CLAIMS

1. A rectifying diode comprising a first electrode, a second electrode with a minimum separation of d between the first and second electrodes, and an organic semiconductor material in between the first and second electrodes with a ratio of SA over PA smaller than 10 where SA is the area of all points on the surface of the first electrode that lies within a distance of 3 x d from any point on the second electrode and PA is the product of d and the length of the perimeter of SA

2. A rectifying diode as claimed in claim 1, wherein at least one of said first and second electrodes is deposited from a liquid.

3. A method of forming a diode including semiconductor material between first and second electrodes, the method including the steps of: (a) forming the first electrode on a substrate; (b) depositing a layer of the semiconductor material over the substrate and the first electrode; and (c) then forming the second electrode over the layer of the semiconductor material; wherein the first electrode is formed so as to induce during step (b) one or more topographic features at selected surface locations of the layer of semiconductor material that are used in step (c) to control the degree of overlap of the second electrode with the first electrode.

4. A method as claimed in claim 3, comprising the additional step of treating the surface of the semiconductor prior to step (c) by a method which has a different effect on the raised and lowered portion of said topographic features.

5. A method of forming a rectifying diode including semiconductor material between first and second electrodes, wherein the formation of the first and second electrodes comprises forming a layer of electrode material on a substrate; embossing the substrate to force a selected portion of the layer of electrode material down into the substrate in a direction substantially perpendicular to the layer of electrode material such that the selected portion and the remainder of the layer of electrode material are shorn apart.

6. A method of forming a diode including semiconductor material between first and second electrodes, the method including the steps of: forming the first electrode on a substrate; forming a layer of semiconductor material over the first electrode; forming over the layer of semiconductor material a structure of insulator material including one or more viaholes; and filling the one or more viaholes with electrode material to thus form the second electrode.

7. A method as claimed in claim 6, wherein the diameter of the viaholes is less than the thickness of the semiconductor layer.

8. A method according to claim 6, wherein the structure including via holes is formed by: depositing a layer of insulator material over the layer of semiconductor material; and forming the one or more via holes in said layer by embossing.

9. A method according to claim 6, wherein the structure including via holes is formed by depositing a layer of insulator on the layer of semiconductor material and inducing the formation of pinholes in said layer.

10. A method for fabricating a rectifying diode on a substrate, comprising:
forming a first electrode of a first conductive material in a first region of the substrate,
depositing a liquid comprising a second conductive material to come in contact with the first electrode and to form a second electrode of the second conductive material in a second region of the substrate spaced from the first region,
preparing the surface of the first electrode prior to the deposition of the liquid comprising the second material to repel the liquid,
wherein the shortest distance between the first electrode and the second electrode defines the thickness of the active semiconducting layer of the rectifying diode.

11. A method as claimed in claim 10, wherein the method comprises the additional step of depositing at least one semiconducting layer in the region between the first and second electrodes.

12. A method as claimed in claim 10, wherein the first electrode is also deposited from a liquid.

13. A method as claimed in claim 10 to 11, wherein the composition of the first body has a tendency to segregate to form a surface region over the first material, the surface region having a different composition from the first material.

14. A method as claimed in claim 13, wherein said surface region is semiconducting, and forms at least part of the active semiconductor layer of the rectifying diode.

15. A method as claimed in any of claims 10 to 14, wherein the first and second materials are essentially the same.

16. A method as claimed in any of claims 10 to 15, wherein the first composition is a solution of at least two components having a tendency to segregate.

17. A method as claimed in claim 16, wherein one of the components is a polymer with a tendency to segregate to the surface of the first composition.

18. A method as claimed in claim 16 or 17, wherein one of the components is a diblock copolymer comprising a relatively polar and a relatively non-polar block.

19. A method as claimed in claim 16, wherein one of the components is a surfactant.

20. A method as claimed in claims 10 to 19, comprising treating the first body prior to deposition of the liquid of the second composition so as to modify at least one physical or chemical property of the surface of the first electrode, thereby forming a surface region over the first material.

21. A method as claimed in claim 20, wherein the step of modifying the surface of the first electrode comprises exposing the substrate to a plasma.

22. A method as claimed in claim 21, wherein said plasma contains fluorinated species.

23. A method as claimed in claim 10 to 22 wherein the surface of the first and second electrodes exhibit different workfunctions.

24. A method as claimed in claim 23, wherein the difference in work function between the first and second electrodes is generated by the step of preparing the surface of the first electrode prior to the deposition of the liquid comprising the second material.

25. A method as claimed in claim 23, wherein the surface of the first and/or second electrodes are treated after being deposited to modify the workfunction of at least one of the first and second electrodes.

26. A method as claimed in claim 25, where in the conductive material of the first electrode has a different workfunction than the conductive material of the second electrode.

27. A method as claimed in any preceding claim, wherein the current flow in said rectifying diode is in the plane of the substrate.

28. A method as claimed in any preceding claim wherein said shortest distance between the first and second electrodes is less than 500 nm.

29. A method as claimed in any preceding claim wherein said shortest distance between the first and second electrodes is less than 100 nm.

30. A method as claimed in any preceding claim wherein said shortest distance between the first and second electrodes is less than 10 nm.

31. A method as claimed in any preceding claim, wherein the material of at least one of the first or second electrodes is a conducting polymer.

32. A method as claimed in any of claims 10 to 31, wherein the material of at least one of the first or second electrodes is a printable metal.

33. A method of forming a recifying diode comprising the steps of (a) forming on a substrate a first electrode (b) depositing at least one semiconducting layer over said first electrode (c) depositing a first dielectric material to form a first dielectric body in a first region of the substrate (d) depositing a liquid comprising a second dielectric material to come in contact with the first dielectric body and to form a second dielectric body in a second region of the substrate spaced from the first region,
(e) preparing the surface of the first dielectric body prior to the deposition of the liquid comprising the second dielectric material to repel the liquid, and (f) depositing a second electrode on top of the first and second dielectric body, wherein the current flow in the rectifying diode between the first and second electrodes is confined to the region in between the first and second dielectric body.

34. A use for rectifying a radiofrequency alternating voltage signal of one or more diodes including organic semiconductor material between first and second electrodes, wherein the distance, d, between the first and second electrodes across the semiconductor material is made sufficiently small that it lies in a range within which the forward current density between the first and second electrodes across the semiconductor material is inversely proportional to $d^n$, where n is greater than 1.

35. A use for rectifying a radiofrequency alternating voltage signal of one or more diodes including organic semiconductor material between first and second electrodes wherein the distance between the first and second electrodes across the semiconductor material is less than 50nm, preferably less than 20nm, and further preferably less than 10nm.

36. A diode or use according to any preceding claim wherein the organic semiconductor material is a polymer material.

37. A rectifying diode including organic semiconductor material between first and second electrodes, wherein the reciprocal of the product of the forward resistance and the capacitance for the diode is less than 10 microseconds.

38. A rectifying diode including organic semiconductor material between first and second electrodes, wherein the reciprocal of the product of the forward resistance and the capacitance for the diode is less than 100 nanoseconds.

39. A rectifying circuit including one or more diodes according to any preceding claim.

40. A diode produced by a method according to any of claims 10 to 33.

41. A rectifying circuit including one or more diodes according to claim 40.

42. A rectifying circuit as claimed in claim 41, where the rectifying circuit is a Villard cascade.

43. A diode including first and second solution-processed electrodes on a surface of a substrate and semiconductor material also on said surface of the substrate between the first and second electrodes.

44. A diode according to claim 43, wherein the semiconductor material also extends over the top of the first and second electrodes.

45. A diode according to claim 43 or 44, wherein the thickness of each of the first and second electrodes at respective opposing edge portions thereof decreases towards each other.

46. A use for rectifying a radiofrequency alternating voltage signal of one or more diodes including organic semiconductor material between first and second electrodes, wherein the distance, d, between the first and second electrodes across the semiconductor material is made sufficiently small that it lies in a range within which the forward current density between the first and second electrodes across the semiconductor material is inversely proportional to $d^n$, where n is greater than 1.

47. A use for rectifying a radiofrequency alternating voltage signal of one or more diodes including organic semiconductor material between first and second electrodes wherein the distance between the first and second electrodes across the semiconductor material is less than 50nm, preferably less than 20nm, and further preferably less than 10nm.

48. A diode or use according to claim 46 or 47 wherein the organic semiconductor material is a polymer material.

49. A method of forming a diode including semiconductor material between first and second electrodes, the method including the steps of: (a) forming the first and second electrodes by a method including depositing liquid including electrode material or a precursor thereto at respective separate locations on a substrate surface and then (b) depositing the semiconductor material on the substrate surface between the electrodes, wherein one or more of the substrate surface, the deposition conditions and the subsequent drying conditions are controlled so as to form first and second electrodes each having a thickness profile at respective opposing edge portions thereof that decreases outwardly towards each other.

50. A method of forming a diode including semiconductor material between first and second electrodes, the method including the steps of: (a) forming the first electrode on a substrate; (b) depositing a layer of the semiconductor material over the substrate and the first electrode; and (c) then forming the second electrode over the layer of the semiconductor material; wherein the first electrode is formed so as to induce during step (b) one or more features at selected surface locations of the layer of semiconductor material that are used in step (c) to control the degree of overlap of the second electrode with the first electrode.

51. A method according to claim 50, wherein the first electrode is formed by depositing a liquid including electrode material or a precursor thereto on the substrate and then drying; wherein one or more of the nature of the substrate surface on which the liquid is deposited, the composition of the liquid and the drying conditions are selected such that the thickness of the dried deposit has a maximum at an edge portion thereof.

52. A method according to claim 50, wherein the one or more features at selected surface locations of the layer of semiconductor material are topographical features, and including the step of using the one or more topographical features in a stamping step to determine a surface energy pattern for controlling the positioning of the second electrode.

53. A method according to claim 52, wherein the first electrode is formed as at least two portions spaced by a distance corresponding to the width of the second electrode.

54. A method according to claim 50, including the step of forming on the substrate a layer structure at least including a first electrode layer, topologically patterning the layer structure; conformally depositing semiconductor material over the patterned layer structure such that it forms a layer having a topological pattern substantially corresponding to that of the first electrode layer; and then depositing second electrode material or a

precursor thereto over the semiconductor material, wherein the topological pattern of the semiconductor layer is used to control the deposition of the second electrode material.

55. A method according to claim 54, wherein the topological pattern of the semiconductor layer is used to directly control the deposition of the second electrode material.

56. A method according to claim 54, wherein the topological pattern of the semiconductor layer is used to control an intermediate surface-energy patterning step for controlling the deposition of the second electrode material.

57. A method according to claim 55, wherein the step of structurally patterning the layer structure is done by embossing sharp grooves into the layer structure and the underlying substrate.

58. A method according to claim 55, wherein the layer structure includes a layer of insulator material over the first electrode layer, and wherein the topological patterning step includes exposing selected portions of the first electrode layer for contact with the subsequently deposited semiconductor material.

59. A method of forming a diode including semiconductor material between first and second electrodes, wherein the formation of the first and second electrodes comprises forming (i) a layer of electrode material on a substrate; (ii) forcing a selected portion of the layer of electrode material down into the substrate in a direction substantially perpendicular to the layer of electrode material such that the selected portion and the remainder of the layer of electrode material are shorn apart.

60. A method according to claim 59, wherein the substrate is at least partly formed of semiconductor material such that said selected portion and said remainder are electrically connected by semiconductor material directly after step (ii).

61. A method according to claim 59, further including a step (iii) of depositing semiconductor material over the layer of electrode material so as to form a semiconductor connection between said selected portion and said remainder.

62. A method of forming a diode including semiconductor material between first and second electrodes, the method including the steps of: forming the first electrode on a substrate; forming a layer of semiconductor material over the first electrode; forming over the layer of semiconductor material a structure of semiconductor or insulator material including one or more via-holes; and filling the one or more via holes with electrode material to thus form the second electrode.

63. A method according to claim 62, wherein the formation of the structure including one or more via holes includes: depositing a layer of semiconductor or insulator material over the layer of semiconductor material; and then forming the one or more via holes in said layer by embossing.

64. A method according to claim 63, wherein the layer of semiconductor material formed over the first electrode and the structure including one or more via holes are made of the same semiconductor material and are deposited in a single step.

65. A method according to claim 62, wherein the formation of the structure including one or more viaholes includes depositing droplets including insulator or semiconductor material at spaced-apart locations on the layer of semiconductor material.

66. A method according to claim 65, including the step of patterning the surface of the layer of semiconductor material to control the deposition of the droplets.

67. A method according to claim 65, including the step of controlling the drying of the droplets so as to favour the formation of respective dried deposits having a relatively sharp thickness profiles at opposing edges thereof.

68. A method according to claim 62, wherein the structure including via holes is formed by depositing a layer of insulator or semiconductor material on the layer of semiconductor material and inducing the formation of pinholes in said layer.

69. A method according to claim 68, wherein the step of inducing the formation of pinholes includes inducing stress in said layer.

70. A method according to claim 68, wherein the step of inducing formation of pinholes includes contacting said layer with an array of pointed structures at a temperature at which the pointed structures cause said layer to breakup locally thereunder.

71. A method according to claim 70, wherein said layer is a layer of a polymer material and is contacted with the array of pointed structures at or above the glass transition temperature of the polymer layer.

72. A diode produced by a method according to any of claims 49 to 71

73. A rectifying circuit including one or more diodes according to claim 72.